PROXIMITY SWITCH WITH SNAP LOCK

This application claims benefit of the 25 Oct. 2010 filing date of U.S. provisional patent Application No. 61/406,350, and the 1 Feb. 2011 filing date of U.S. provisional patent Application No. 61/438,445.

FIELD OF THE INVENTION

This invention relates generally to magnetic proximity switches, and particularly to such switches designed for sensing and monitoring the operating position of critical industrial equipment, and opening or closing an electrical circuit in response thereto.

BACKGROUND OF THE INVENTION

Magnetic proximity switches are used, for example, to sense the position of an industrial valve, for example in nuclear power plants. A magnet or magnetic material called a "target" may be mounted on the valve stem. A magnetic proximity switch is located adjacent to the valve stem so that the target moves within a given distance of the switch when the valve is in a given position, such as fully open or fully closed. The target in this position attracts a magnet in the switch, which closes and/or opens electrical contacts in the switch, resulting in a signal being communicated to a controller. Two proximity switches may be used—one for the open valve position and one for the closed valve position. In this configuration the two switches can confirm each other and can verify that full opening or closing has occurred. An example of such a switch is described in U.S. Pat. No. 7,489,217.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained in the following description in view of the drawings that show:

FIG. **1** is a side view of internal parts of a proximity switch according to aspects of the invention with a switch housing in section.

FIG. **2** is a sectional view taken along line **2-2** of FIG. **1**.

FIG. **3** is a top view of internal parts of the switch with the shaft support partly cut away to show part of the outer shaft.

FIG. **4** is a top view of the outer shaft.

FIG. **5** is a sectional view of the entire switch taken along a plane of line **5-5** of FIG. **3**, with a magnetic target in range, causing leftward movement of the sensor magnet and the movable contact.

FIG. **6** is a sectional view as in FIG. **5**, with no magnetic target in range, resulting in rightward movement of the sensor magnet and the movable contact.

FIG. **7** is a perspective view of internal parts of the switch.

FIG. **8** is a side sectional view of an embodiment with a connector pin-out adapter.

FIG. **9** is a schematic view of a flexible circuit that connects the switch output leads to input pins on the connector adapter block.

FIG. **10** is a perspective view of the embodiment of FIG. **8**.

FIG. **11** is a connector-end view of the embodiment of FIG. **8**.

FIG. **12** shows an end of the flexible circuit configured for six active pin-out conductors for a double-pole double-throw configuration of the switch.

FIG. **13** shows an end of the flexible circuit configured for three active pin-out conductors for a double-pole double-throw configuration of the switch.

DETAILED DESCRIPTION OF THE INVENTION

The present inventors have recognized premature contact wear in prior art magnetic proximity switches, and further have recognized that the wear can result from electrical sparking during contact bounce. The inventors have further recognized that such contact bounce may occur as a result of closure rebound or from operational vibrations and seismic events. The present invention addresses these problems.

FIGS. **1** and **2** show a proximity switch **20** with a housing **22** that has a cable coupler **24** for a signal cable on the right end. Herein, "right" and "left" will be used for convenience to mean toward the cable end **24** of the housing and toward the sensor end **43** of the housing respectively, as shown in FIG. **1**. The coupler **24** may have internal threads as known in the art. An inner shaft **26** slides linearly within an outer shaft **28**, which slides linearly between the housing **22** and a shaft support **29** that is fixed relative to the housing. A contact block **30** is attached to the right end of the outer shaft **28**. It supports one or more bi-directional movable contacts **32** that alternately close against first and second fixed contacts **34**, **38**. This switching action alternately creates and breaks continuity between pairs of leads **36** held by a lead block **37**.

A sensor magnet **42** is attached to the left end of the inner shaft **26** in a retainer **27**, and functions as a magnetic target proximity sensor. A return spring **44** urges the inner shaft rightward. An engagement pin **46** is attached to the inner shaft **26** and extends through a slot **45** in the outer shaft **28** and through a slot **47** in the shaft support **29**. The engagement pin **46** alternately pushes open one of two locking claws **48**, **52**. In FIG. **1** the pin **46** is moving leftward, and is pushing open the left claw **52**. Each claw **48**, **52** pivots to hook or release a respective locking post **56**, **58**. The locking posts **56**, **58** extend from the outer shaft **28** through slots **57**, **59** in the shaft support **29**. Each claw **48**, **52** is urged toward its locked position by a respective spring **49**, **53**. The claw axles **50**, **54** extend from the shaft support **29**, thus they remain in a fixed location relative to the housing **22**.

FIG. **2** is a sectional view taken along line **2-2** of FIG. **1**. A valve stem **60** (not necessarily to scale) is shown proximate the left end **43** of the proximity switch **20**. A magnet **62** or magnetic material may be attached to the valve stem to function as a target for the proximity switch. When the valve stem **60** is in a given position, the target is opposite the left end or sensor end **43** of the proximity switch **20**, and thus attracts the sensor magnet **42**, which moves the inner shaft **26** leftward. This moves the engagement pin **46** leftward, which opens the left claw **52** as shown in FIG. **1**.

Before this claw release occurs, the outer shaft **28** is locked into position relative to the housing **22** so that the left movement of the inner shaft **26** compresses a spring **64** that is retained between two spring blocks **66**, **68** that slide within a spring chamber **65** in the inner shaft **26**. Movement of the spring blocks **66**, **68** is limited by guide pins **67**, **69** that extend from the spring blocks through guide slots **70** in the inner shaft **26** and through corresponding guide slots **71** in the outer shaft, as later shown. This spring mechanism **64**, **66**, **67**, **68**, **69**, **70**, **71** causes an accumulation of spring force that urges the outer shaft **28** in the direction of movement of the inner shaft **26**, so that when the respective claw (**52** for leftward movement) is released by the engagement pin **46**, the outer shaft suddenly moves relative to the housing in the direction of the inner shaft, either left or right (leftward in the illustrated case). This causes the movable contact **32** to close suddenly against the left or right stationary contact respectively (the left contact **34** in this case). At that time, the opposite claw (the rightward claw **48** in this case) hooks the opposite locking